

HYPER SPECTRAL IMAGING



INTRODUCTION

TACOM-ARDEC began developing Hyper-Spectral Imaging (HSI) in 1993. Among their many applications, HSI cameras work well for finding objects among clutter. The challenge of HSI is that it creates a massive volume of data that needs reduction to a simple and meaningful image for the user. Most medical, military, or commercial applications want the HSI output frame (the image after processing) rate to be as fast as, or faster than, common video cameras. ARDEC's strong point is real-time analysis and the displaying of results as an image for quick human comprehension.

HSI PROCESSING

A HSI camera acquires tens to hundreds of input frames of the same scene for a single output frame. Each input frame is an image of the scene taken within a narrow spectral region. For example, a narrow spectral region might be blue or green. The camera acquires a stack of frames called a "data cube," which can fill more than 100 megabytes of memory.

Processing of the data cube requires an understanding of the physics of interaction of light with matter. A camera must not require the end user to understand the physics, but rather must change the raw data into an output frame in which the objects of interest are highlighted and viewed in relation to all other objects in the scene. Among those calculations are calibration and correction for effects of the atmosphere, variation in the detector elements, correction for chromatic aberration, and correction for the response of the detector for the various spectral regions. The processing speed must be adequate to apply correction factors, have time for analysis of the object, and time for display of the results. Over 50 million data points must go through multiple operations before an output frame is displayed.

Typical HSI cameras are large, cumbersome and come as multiple units that are tied together with electric cables, etc. Processing of the data cube is generally done well after the data cube is acquired. Typically, results of processing are unknown for several minutes to hours later.

UNIQUENESS OF ARDEC'S SYSTEM

TACOM-ARDEC made the hardware processor small enough to fit directly inside the camera box so that the entire unit is about the size of a boot box and weighs about 10 pounds. The camera acquires, processes and displays results at a rate greater than ten cubes per second. Calibration and correction factors are imbedded in the processor. The same hardware processor can be used in cameras independent of the detector, e.g., visible and infrared. Only the calibration and correction factors need to be chosen for the detector used.

The processing algorithms filter the data to find those objects in the scene of similar or identical spectral characteristics. Filters can be created on the fly by selecting a region in the scene and using its spectrum as the filter. Filters can be saved and used at any later time.

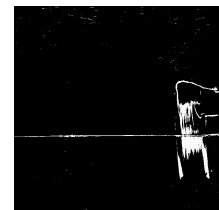
TACOM-ARDEC has initiated development of a high-speed camera that can acquire the entire data cube simultaneously. This will reduce blurring due to a moving object during acquisition and also enable cube rates on par with fast video rates.

RESULTS

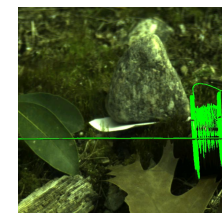
Literally, thousands of diagnostic and identification processes will experience tremendous benefit from HSI. Applications exist in the medical, military and commercial sectors. ARDEC is currently assessing the camera's value for multiple applications. As one example of a military application, the visible version of the camera works well for finding wires among clutter, as can be seen in the images below. This is a very difficult task without using hyperspectral imaging.



Original Image



Wire identified



Wire false colored

LEVERAGING PARTNERS

Surface Optics Corporation of San Diego, CA has been ARDEC's partner in the development of cameras to date.

For additional information, please contact

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